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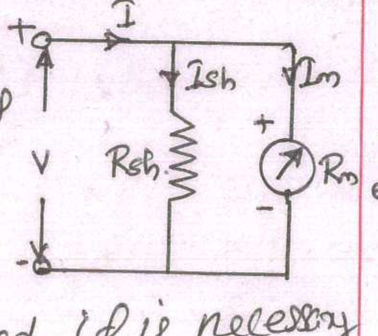
SCHEME OF VALUATION
(Scoring Indicators)

Revision - 2015

Course Code - 4041

Course Title - Electronics Instruments And Measurements

Qst No.	Scoring Indicator	Splitup Score	Sub Total	Total
	PART-A			
I. 1.	It is the closeness or nearness to which an instrument can read the true or actual value of the quantity or variable being measured	2	2	
2.	(a) Measurement of voltage and current b. Measurement of phase, power and power factor	1+1	2	
3.	When a number of thermocouples are connected in series it is called a thermopile.	2	2	
4.	(a) Measurement of signal purity (b) Modulation characteristics (c) pulse shape analysis (d) Noise measurement	1x2	2.	
5.	A system in which the controlling action or input is somehow dependent on the output or change in output is called a closed loop system.	2	2	
	PART-B			
II. 1.	Advantages:- The input impedance is high; frequency range is high; Simple circuit; Cost is less; Construction is rugged; It is less suffered from electric noise Disadvantages:- Accuracy is less; resolution is poor; Not compact in size; reliability and repeatability are poor.	3+3	6	
2.	The basic movement of a d.c ammeter is a PMMC galvanometer. The coil winding of a basic movement is small and light, it can carry only very small currents when large currents are to be measured, it is necessary to bypass a major part of the current through a resistance called a shunt resistor as shown in fig. The resistance of shunt can be calculated using conventional circuit analysis. 	fig-2 exp-4	2+4 =6	6

Where, R_{sh} = resistance of the shunt; R_m = internal resistance of the movement; I_m = full scale deflection current of the movement; I_{sh} = Shunt current
I = Total current

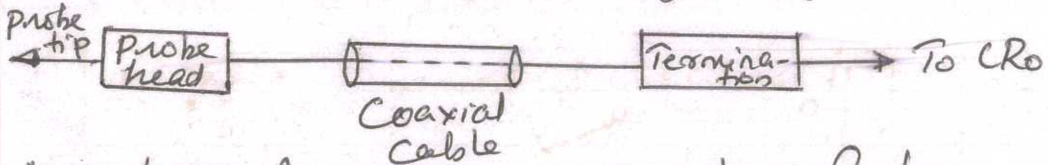
Since the resistance is in parallel with the meter movement, the voltage must be the shunt and the movement must be same

$\therefore V_m = V_{sh}$ $\therefore I_m R_m = I_{sh} R_{sh}$.

$\therefore R_{sh} = \dfrac{I_m R_m}{I_{sh}}$ ie, $I_{sh} = I - I_m$.

$$\therefore R_{sh} = \frac{I_m R_m}{I - I_m}$$

3. A probe is a conductor used to establish a connection between the circuit under test and the measuring instrument. While connecting the test circuit the probe does not alter, load or distort the circuit and signal conditions to be analysed. The probe should have high impedence, the probe bandwidth should be as high as possible.



Many types of probes can classified below
(1) Direct probe (2) Isolation probe (3) High impedence or 10:1 probe (4) Active probe (5) Current probe (6) Differential probes etc... Defn - 1, fig - 1, types - 4 | 1+1+4 = 6 | 6

Direct probe :- The simplest types of probe are the test lead. Test leads are simply convenient lengths of wire connecting the CRo input to the point of observation. At the end of CRo, they usually terminate with lugs, banana tips or other tips to fit input jacks of the scope, and at the other end has a crocodile clip or any other convenient means for connection to the electronic circuit.

Isolation probe: The input capacitance of the scope and the stray capacitance of the test lead are very high. It causes the sensitive to break into oscillation when CRO connected. This effect can be prevented by an isolation probe.

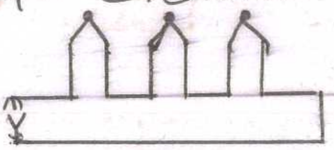
High impedence (10:1) probe: This probe is also known as passive voltage probe. The basic function of this probe is to increase the input impedence and reduce the effective input capacitance of an oscilloscope. The probe head uses a resistor and capacitor combination.

Active probe: The active probes are used for connecting fast rising and high frequency signals. These probes are very useful for small signal measurements as their attennuation factor is very small.

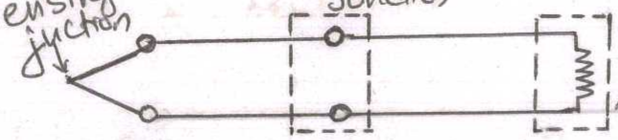
Current probe: This probe provides a method of inductively coupling the signal to the CRO input. The direct electrical connection between the test circuit and CRO is not necessary. This probe can be clamped around a wire carrying an electrical current without any physical contact to the probe.

Differential probes: It is a type of active probe. It has a two inputs, positive and negative. It has a seperete ground lead and it drives single terminated 50-Ω cable to transmit its output to one oscilloscope channel.

4.



(b)



(a)

fig-2 exp 4 2+4 =6 6

A thermo couple is formed by joining two dissimilar metals. The junction is called the sensing or hot end. The other ends are called the reference or cold ends. When there is a raise in temparature between the cold end and hot end of the thermo couple, a voltage is produced which drives a current through the recorder or meter. The current produced is propotional to the temparature difference between hot and cold ends of the thermo couple as shown in fig (a). As the current indicated by the indicating instruments is propotional to the difference of temparature, these thermo couples are used for temparature sensing, heat flow and heat radiation detection.

When numbers of thermocouples are connected in series it is called a thermopile as shown in fig (b). Thermocouples are manufactured from different metal alloys. The usual operating temperature ranges from -270°c to 2700°c. They are made in un-insulated wire form or may be incorporated in protective sheaths or probes. They are preffered industrial furnaces and in measurement in cryogenic range because of the temperature range offered.

5. 1. The balance equation is independent of the magnitude of the input voltage or its source impedance.
2. The measurement accuracy is high as the measurement is done by comparing the unknown value with the standard value. | 1x6 | 6 | 6
3. The accuracy is independent of the characteristics of a null detector and is dependent on the component value.
4. The balance equation is independent of the sensitivity of the null detector, the impedence of the detector or any impedence shunting the detector
5. The balance condition remains unchanged if the source and detector are interchanged.
6. The bridge circuit can be used in the control circuits

6.

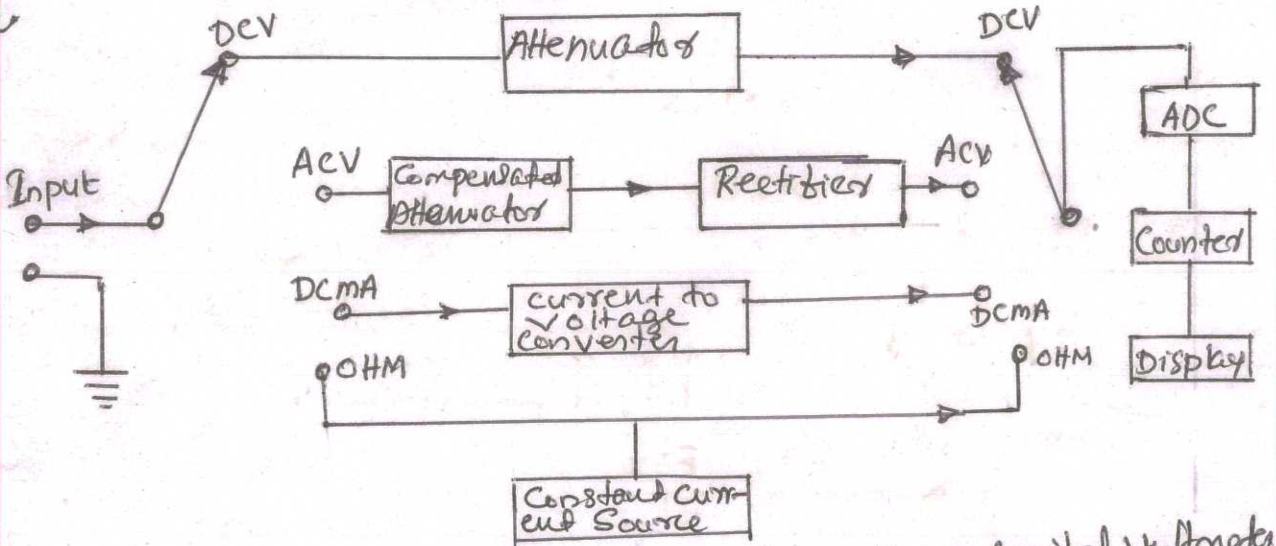
Sl No.	open loop	closed loop
1.	Any change in output has no effect on the input	change in out, effect the input
2.	Output measurement is not required for operation of system	* Output measurements is necessary
3.	Feed back element is absent	* Feed back element is present
4.	Error detector is absent	* Error detector is necessary
5.	It is inaccurate and unreliable	* Highly accurate and reliable
6.	Highly sensitive to the disturbances	* Less sensitive to the disturbances
7.	Simple construct and cheap	* Complicated to design and hence costly
8	Bandwidth is small	* Bandwidth is large.

1x6 | 6 | 6

7. Telemetry is a system meant for collection of data from different remote locations and transfer the data to a centralized installation. Many electrical sensors will be used that perpetually measure the system operation. The different outputs of the individual sensors will be scanned at fixed intervals. They are multiplexed and transmitted through a suitable link to the centralized data collection centre. At the centralized data collection centre the signals are received. The data will be reconstructed into the required format & will be de-multiplexed. Then the data will be distributed among recording and monitoring systems individually. 6 6 6

PART-C

IIIa



Digital multimeter (DMM) is basically a digital voltmeter and may be used for the measurement of voltage, current (dc or ac) and resistance. All quantities other than dc voltage are first converted into an equivalent dc voltage by some devices. For measurement of ac voltage the input voltage is converted into a dc voltage by means of a rectifier. A compensated attenuator is employed. Many manufactures provides the same attenuator for both ac and dc measurement. For measurement of resistance, a constant current, depending on the range, supplied from a battery or a constant current source is passed through the resistance under measurement and the voltage developed across it is measured. The resistance value displayed in OHM. fig 5 exp 4 | 5+4 =9 | 9

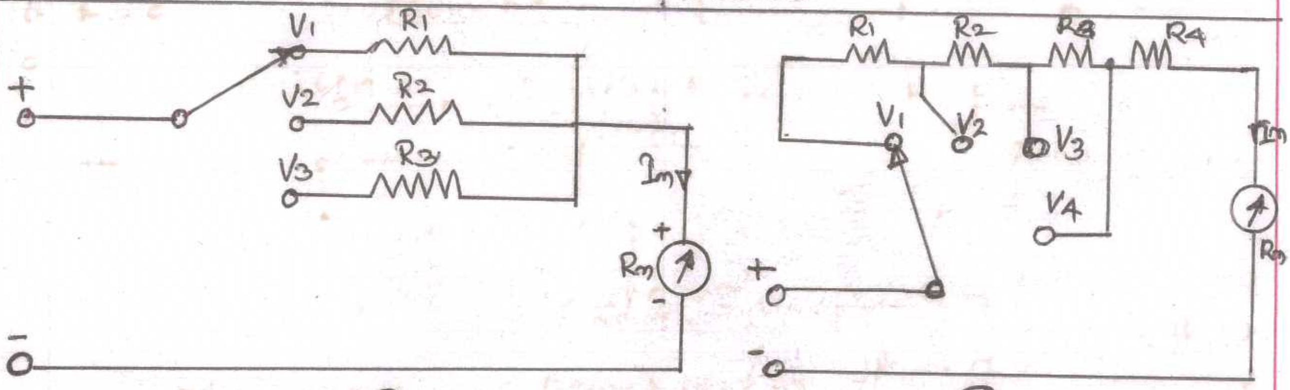
For measurement of current, the unknown current is passed through a precision resistor in many Commercial DMM and the voltage developed across the resistor is measured. The current value is displayed in mA.

b.

Sl No	Moving coil instruments	Moving iron Instruments
1	It is used only for dc measurement	* It can be used for both ac and dc measurement
2.	It is expensive	* It is cheapest
3.	They have a substandard accuracy	* They are very accurate
4.	The scale is uniform	* The scale is not uniform.
5.	Power Consumption is very low.	* Power Consumption is moderate.
6.	Errors are less	* Errors are more.
7.	It is less robust	* It is more robust
8.	These are used in aircraft and aerospace instruments.	* These are used in laboratory and industrial Instruments.

1+6 6 6

IV a)



(a) (b)

The basic moving system, often called the D Arsonval movement, is called a basic meter.

The basic D Arsonval movement can be converted into a multirange voltmeter by connecting a number of resistor (multipliers) along with a range switch to provide a greater number of workable range. Fig (a) shows a multirange voltmeter a three position switch and three multiplier R1, R2, R3 for voltage values V_1, V_2 and V_3.

fig A ckt A 4+4 =8 8

I_m = Full scale deflection current of the movement.

R_m = Internal resistance of movement.

$\therefore R_1 = \frac{V_1}{I_m} - R_m$ for the voltage range V_1

$\therefore R_2 = \frac{V_2}{I_m} - R_m$ for voltage range V_2

$R_3 = V_3/I_m - R_m$ for voltage range V_3.

Fig (b) shows the modified form of multirange voltmeter. In this arrangement, the multipliers are connected in a series string and the range selector select the appropriate amount of resistance required in series with the movement. This arrangement is advantages compared to the fig(a), because all multiplier resistance except the first have the standard resistance value and also easily available in precision tolerances.

b. Specifications of Analog multimeter

AC/DC voltage ranges : 0.5/1.5/3/5/12/15/30/50/120/150/300/500V

AC/DC current ranges : 200μA/2/20/200mA/1A/10A

Resistance ranges : 0.2Ω to 100MΩ — 1×7 | 7 | 7

Input impedence : 11MΩ for AC

Accuracy : ± 3%

Frequency response : 500KHz

dB scale : 0dB corresponding to 1mW across 600Ω

Centre zero scale : Available in all AC/DC voltage range

Va.

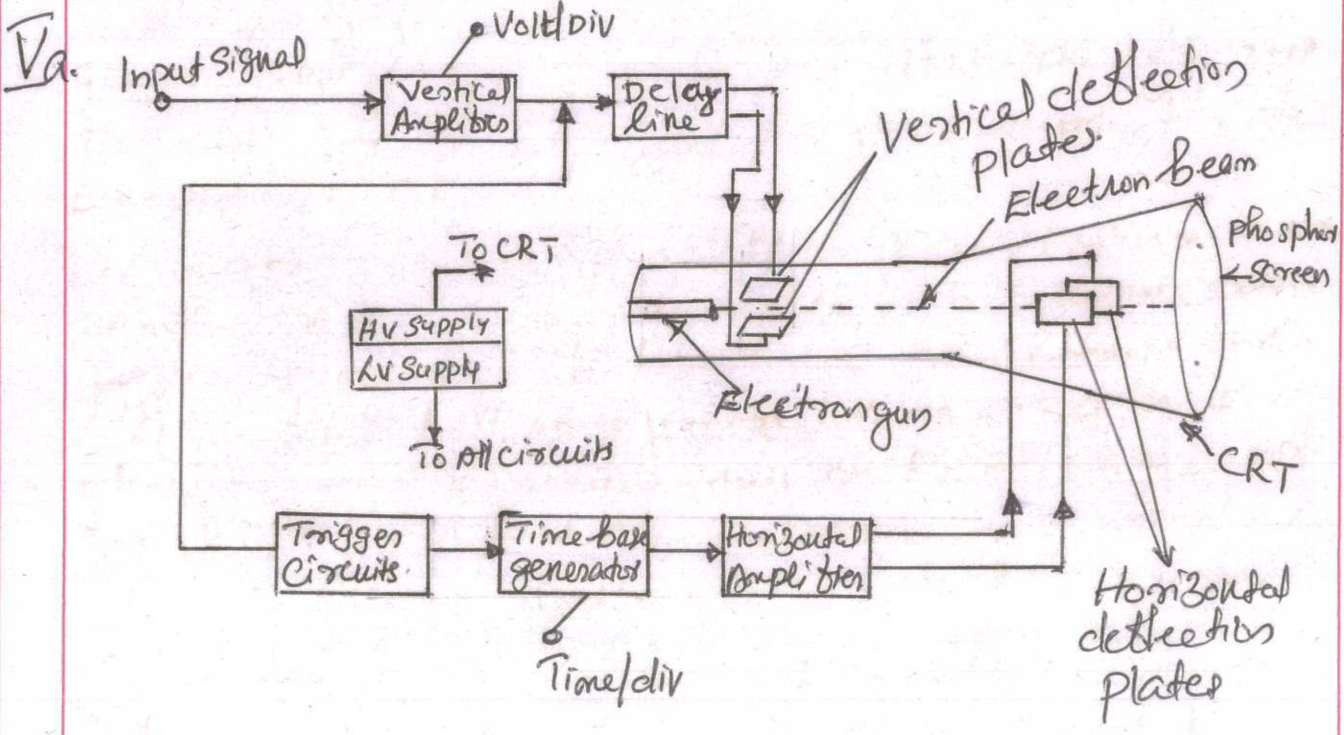


fig 5, Exp 4 | 5+4 = 9 | 9

As shown in the block diagram, having a main blocks are given below.

Cathod ray tube (CRT): The heart of CRo. The CRT produce sharply focussed beam of electron which strikes a fluorescent screen and produces a bright spot of light. This electron beam is made to move both horizontal and vertical direction to produce the waveform.

Vertical Amplifier:- The signal to be observed on the screen of CRO is fed to the input of the amplifier. The output of the amplifier is fed to the vertical deflection plates of the CRT

Delay line:- It is used to delay the signal for some time in the vertical section.

Time-base generator:- The time-base generator or sweep generator is used to generate the sawtooth voltage required to deflect the beam in the horizontal section. The rate of the sawtooth waveform is controlled by a control on the front pannel of the CRo marked time/div.

Horizontal Amplifier:- This amplifier either output of time-base generator is fed to the amplifier. The output of the amplifier is applied to horizontal deflection plates in push-pull form.

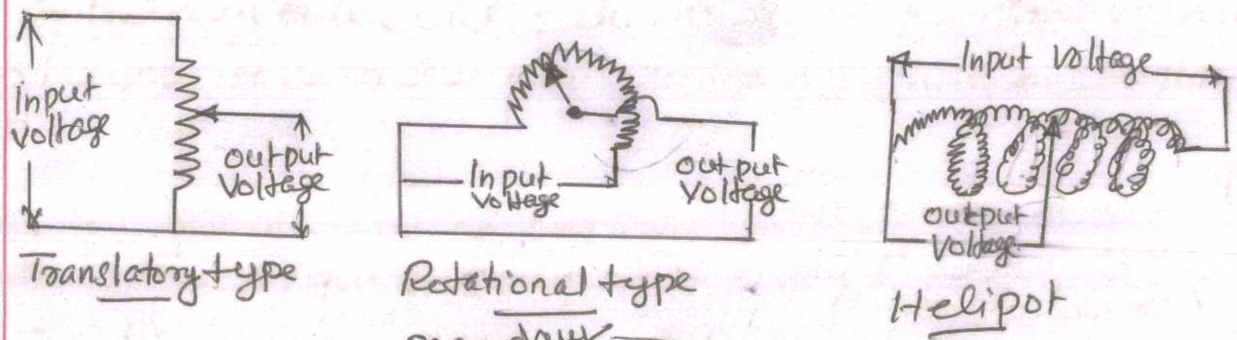
Trigger Circuits: The circuit produces a pulse called trigger pulse from the input wave form. This trigger pulse is used to start the time-base generator which in turn start the horizontal sweep of the CRT spot from the left hand side of the screen.

Power Supply: This consists of a HV supply required for operating the CRT and LV power supply used for other circuits of CRo.

b) A potentiometric transducer is an electromechanical device. It is a passive transducer. It requires external power source for it functioning. It contains a resistance element, that is provided with a slider or wiper. The motion of the wiper may be translatory or rotational. Combination of translator and rotational motion leads to helical movement. Such potentiometers are called helipots. The translatory resistive element are linear devices, rotational resistive devices are circular. They are used for the measurement of angular

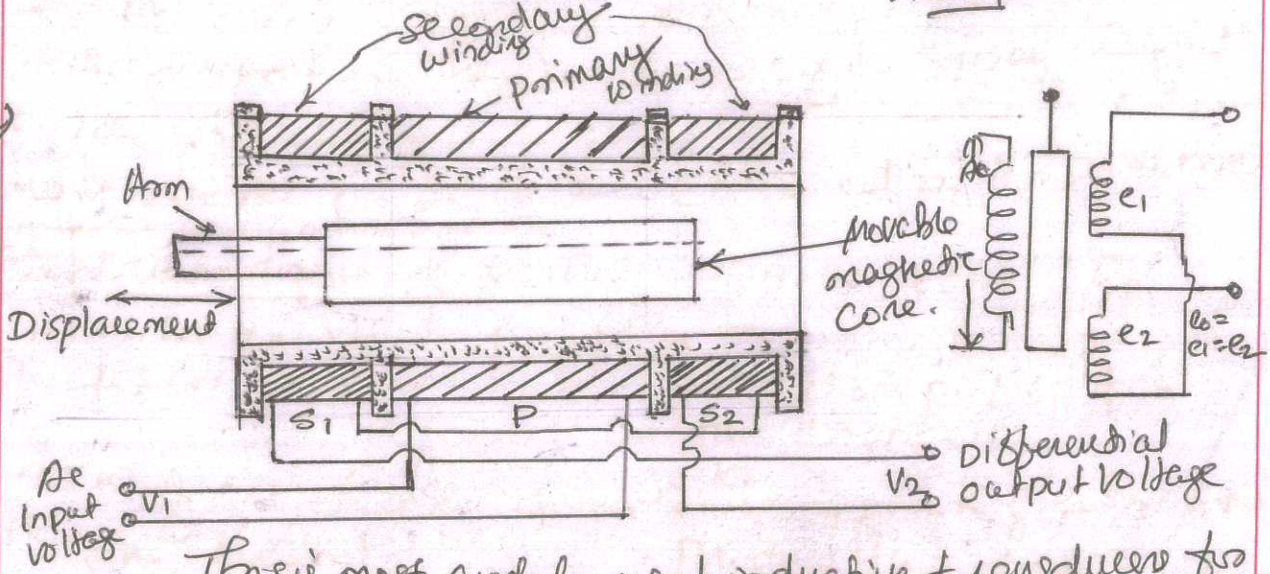
fig 3 / exp 3 — 3+3 =6 — 6

displacement. Helipots are multi turn rotational devices They can be used for either translatory or rotational motion.



VI

a)



This is most widely used inductive transducers for translating linear motion into an electrical signal. The differential transformer is an electromechanical transducer which produces an electrical output proportional to the displacement of a movable core. fig A exp 5 A+5 = 9 9.

The LVDT is a differential transformer consisting of one primary winding P and two identical secondary windings S_1 and S_2 wound over a hollow bobbin of non-magnetic and insulating materials. The secondary winding S_1 and S_2 are equal number of turns, are arranged concentrically and placed either side of the primary winding. A soft iron core, attached to the sensing element of which displacement is to be measured. The primary winding is connected to the ac source and secondary coils are connected in phase opposition. The voltage induced in the two secondary coils are dependent upon their respective induction with primary winding. This is governed by the position of the core. There exist a null position of the movable core when both secondary coils induce the same voltage ie, $e_1 = e_2$. Then e_0 the output voltage is equal to zero. A slight movement of the core upwards from this position will produce varia-

tion in the coupling and e_1 will greater than e_2.
$\therefore e_o = e_1 - e_2$ - will be non zero.
If the displacement takes place in the downward direction from the null position, e_2 greater than e_1 $\therefore e_o = e_2 - e_1$

Advantages: ① Good linearity ② The resolution is infinite ③ High output ④ Good Sensitivity ⑤ low power Consumption ⑥ Rugged in Construction ⑦ low hysteresis

Disadvantages:- ① They are sensitive to stray magnetic fields shielding is required ② The receiving instrument must worker on AC ③ It is effected by temparature.

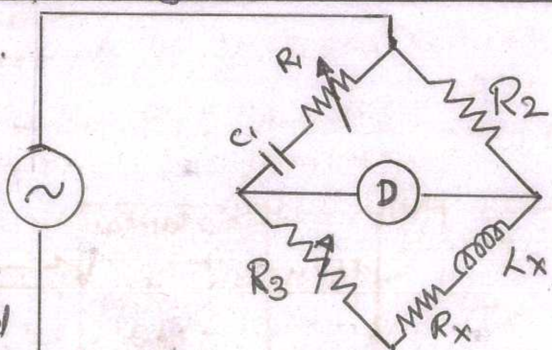
b)

Sl no	Duel-trace CRo	Duel-beam CRo
1.	only one Vertical amplifies is used	* Contains two seperate Vertical amplifiers for two channels.
2.	only one electron gun and one beam.	* Two seperate electron guns Produce two beams
3.	Two signals are switched to a Single Vertical amplifier	* Two signals are fed to two seperate Vertical amplifiers to get two seperate images
4.	Cost is less	* Cost is more.
5.	Different display modes such as alternate, chopped, add etc.. are possible	* Does not have many display modes; but well suited for Simultaneous display of the widely different input signals.

4× 1.5 = 6 6 6

VII

a. Fig. shows the Hay's bridge.



They differ from Maxwell's bridge by having a resistance R_1 in series with a Standard capacitor C_1 instead of parallel. The unknown inductance L_x and its resistance parts are represented by L_x and R_x respectively and other ratio arm used capacitor C_1 and Variable resistance R_1. The other two arms have R_2 & R_3.

At balance,
$$Z_1 Z_x = Z_3 Z_2 \quad \text{—①}$$
where, $Z_1 = R_1 - j/\omega C_1$; $Z_2 = R_2$, $Z_3 = R_3$, $Z_x = R_x + j\omega L_x$

Substituting values in equation no. 1 we get,

$$\left(R_1 - \frac{j}{\omega C_1}\right)(R_x + j\omega L_x) = R_2 R_3$$

$$R_1 R_x + \frac{L_x}{C_1} - \frac{jR_x}{\omega C_1} + j\omega L_x R_1 = R_2 R_3 \quad \text{—(2)}$$

equating the real and imaginary terms we have

$$R_1 R_x + \frac{L_x}{C_1} = R_2 R_3 \quad \text{—(3)}$$

$$\frac{R_x}{\omega C_1} = \omega L_x R_1 \quad \text{—(4)}$$

$$\therefore R_x = \omega^2 L_x C_1 R_1 \quad \text{—(5)}$$

substituting R_x in equation (3)

$$R_1(\omega^2 L_x C_1 R_1) + \frac{L_x}{C_1} = R_2 R_3$$

$$\omega^2 R_1^2 C_1 L_x + \frac{L_x}{C_1} = R_2 R_3$$

multiplying both sides by C_1 we get

$$\omega^2 R_1^2 C_1^2 L_x + L_x = R_2 R_3 C_1$$

$$\therefore L_x = R_2 R_3 C_1 / 1 + \omega^2 R_1^2 C_1^2$$

substituting L_x in equ (5)

we get,

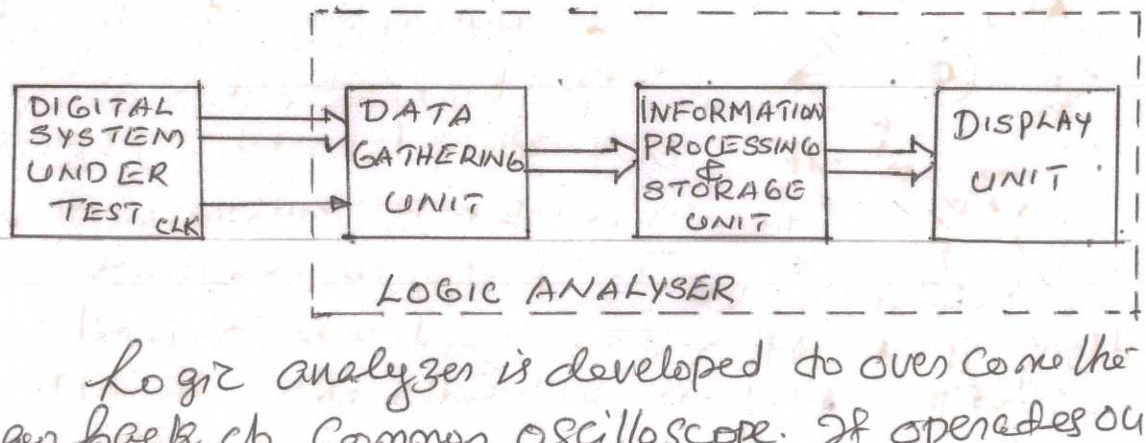
$$\therefore R_x = \frac{\omega^2 C_1^2 R_1 R_2 R_3}{1 + \omega^2 R_1^2 C_1^2}$$

dig 2
exp 2
der 4

2+2+4=8

8

b)



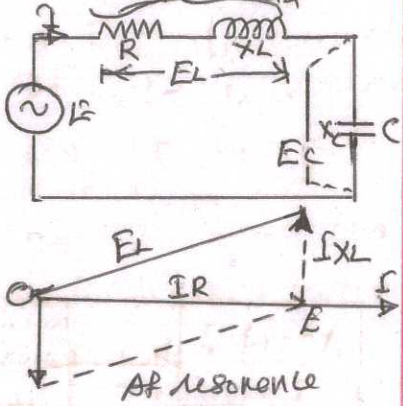
Logic analyzer is developed to overcome the draw back of common oscilloscope. It operates on a slightly different principle than that of a oscilloscope. Because there are many signal lines in a digital system, the data is changing rapidly on each line, a logic analyzer must take a snapshot of the activities on the line and store the logic state of each signal in memory for each cycle of the system clock. The conditions under which the snapshot is taken are determined by triggering circuits, which can respond to various combinations of events.

The logic analyzer enable the activity of many digital signal points to be recorded simultaneously and then examined in details. The information is recorded with respect to a clock signal to determine whether they are HIGH or LOW with respect to a defined threshold voltage. This information is stored in memory and is then available for detailed analysis via logic analyzer's display. The clock signal can be internally or externally generated. fig-3 Exp A | 3+4 =7 | 7

Fig. shows the block diagram of a typical logic analyzer. It has a data gathering unit, information processing and storage unit and a display unit. The data gathering unit has (1) a pod slots for carring data from the digital system under test to the logic analyzer and (2) a key pad. The key pad is used to enter commands and setup the parameters that the logic analyzer will use. The display unit is a CRT that displays the command menu for the operator and also displays the output data.

VIII

a) The Q-meter is an instrument which is designed to measure of the electrical properties of the coils and capacitors by measuring the Q-value of an R-L-C circuit.



Working principle:- It is based on the characteristics of a series circuit

At resonance
$X_L = X_C$
$I = E/R$

fig-4 Exp A | 4+4 =8 | 8

These series resonant has a charaederistics the voltage across the coil or capacitor is equal to the applied voltage times the Q factor of the circuit. The Q factor is called quality factor or storage factor. It is defined as the ratio of power stored in the element to the power dissipated in the element.

The fixed voltage is applied to the circuit, a voltmeter across the capacitor can be calibrated to read Q-directly. The voltage and current relationship of a series resonant circuit are shown in fig.

At resonance, $X_L = X_C$; $E_C = IX_C = IX_L$; $E = IR$.

where, E = applied voltage, I = circuit current

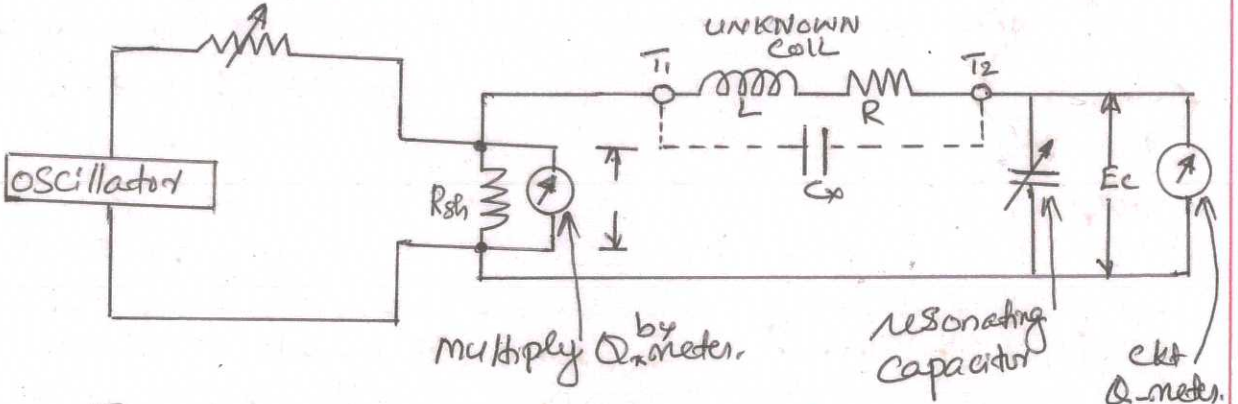
E_C = voltage across the capacitor; X_C = capacitive reactance

X_L = inductive reactance; R = coil resistance.

The magnification of the circuit, by definition is Q, is given by, $Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{E_C}{E}$

Therefore, if E is maintained at constant and known voltage, a voltmeter connected across the capacitor can be calibrated directly in terms of the circuit Q.

Practical Q-meter:



Q-meter circuit consists of a wide range of oscillator with frequency range from 50 KHz to 50 MHz. It delivers current to a low value shunt resistor Rsh. The value of the shunt is very low about 0.02 Ω. It introduce almost no resistance into the oscillatory circuit and it therefore represents a voltage source of magnitude E with a very small internal resistance. The voltage E across the shunt is measured with a thermo couple meter marked "multiple by Q". The voltage across the variable capacitor Ec is measured with an electronic voltmeter whose scale is calibrated directly in Q-values.

Procedure:- The unknown coil is connected to the test terminals of the instrument between T_1 and T_2. The circuit is tuned to the resonance by setting oscillator to a given frequency and varying the internal resonating capacitor or by pre-setting the capacitor to a desired value and adjusting the frequency of the oscillator. The Q reading of the output meter must be multiplied by the index setting of the

"Multiple Q by" meter to obtain the actual Q value. The indicated Q is the resonant reading on the "circuit Q" meter and called the circuit Q. The effective Q of the measured coil will be greater than the indicated Q. The difference is generally neglected.

The inductance of the coil can be calculated from the unknown values of frequency (f) and resonating capacitance (C)

$X_L = X_C$ and $L = \frac{1}{(2\pi f)^2 C}$ henry

b) Fig. shows to measures an unknown inductance in term of a known capacitor. The use of standard arm offers the advantages of compactness and easy shielding. One arm has a resistance R_1 in parallel with C_1 and hence easier to write the balance equation using the admittance of arm 1 instead of the impedance.

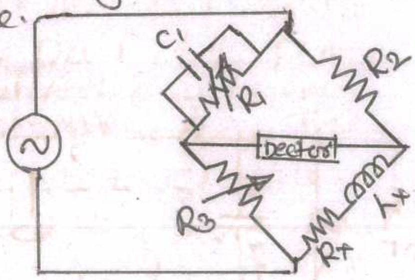


fig. 3

At balance,

$Z_1 Z_x = Z_2 Z_3$;

$Z_x = \frac{Z_2 Z_3}{Z_1} = Z_2 Z_3 Y_1$ — ①

Where, $Y_1 = \frac{1}{Z_1}$

$Y_1 = \frac{1}{R_1} + j\omega C_1$; $Z_2 = R_2$; $Z_3 = R_3$ and $Z_x = R_x + j\omega L_x$

3+4 =7 | 7

substituting these values from equation - ①

$R_x + j\omega L_x = R_2 R_3 \left(\frac{1}{R_1} + j\omega C_1\right)$

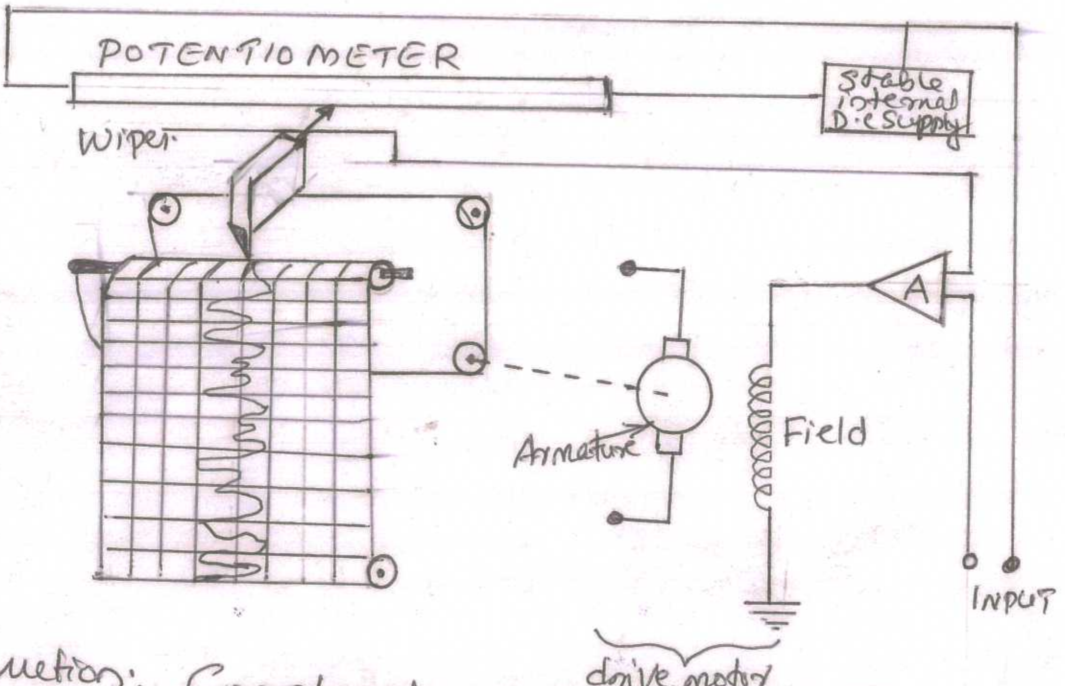
$= \frac{R_2 R_3}{R_1} + j\omega C_1 R_2 R_3$.

equating the real and imaginary terms we have.

$\boxed{R_x = \frac{R_2 R_3}{R_1}}$ and $\boxed{L_x = C_1 R_2 R_3}$

IX

a) The basic disadvantages of the galvanometer recorder is that having very low input impedance and sensitivity. The low input impedance creates a problem of loading. To overcome this, we can use an amplifier which provide high input impedance and reasonably high sensitivity, but accuracy is reduced. To overcome this problem, the input signal is compared with reference voltage.



Construction: Constructional details as shown in the block diagram, it can be seen that the input signal is applied to the amplifier in series with the part of the potentiometer. The potentiometer is supplied with a reference voltage derived from the internal power supply. The output of the internal power supply is made stable. The field coil of the motor is energised by the output of the amplifier. The output of the amplifier is the error signal. The wiper of the potentiometer is connected to the armature of the motor. The wiper carries a pen. The paper feed mechanism moves the paper with a constant speed.

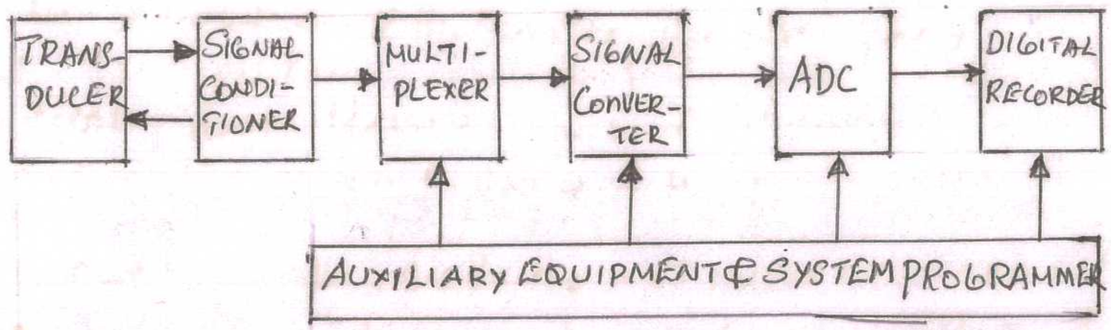
Working:- The difference in the put signal and reference potentiometric voltage produce the error signal. The error signal is amplified and it then energises the field coil of the d.c motor. The error current either flows in the clockwise direction or anticlockwise direction depending on the voltage value. The motor turns such a direction that it reduces error signal to achieve balanced condition. As the error signal starts reducing, the motor slows down and stop completely when error become zero. Thus balanced condition is achieved. As the wiper of the potentiometer is driven by the motor's armature and a pen is arranged over the wiper, the pen executes motion in the direction of movement of the wiper. As the armature moves either direction depending on the error the pen moving in synchronous direction records the waveform. The paper feed motor will be synchronized with power line frequency. Capillary

fig-3 exp 5 | 3+5 =8 | 8

action of a recorder is defined as the process of establishing flow of ink from the reservoir through the tubing and into the hollow of the pen.

b) 1. It must acquire the necessary data at correct speed and at the correct time.
2. It must use all data's efficiently to inform the operator about the state of the plant.
3. It must monitor the complete plant operation to maintain on-line optimum and safe operation.
4. It must provide an effective human communication system and able to identify problem areas, there-by minimizing unit availability and maximizing unit through point at minimum cost. 1×7 7 7
5. It must able to collect summaries and store data for diagnosis of operation and record purpose.
6. It must be able to compute unit performance indices on-line, real-time data.
7. It must be flexable and capable of being expanded for future requirements.
8. It must be reliable and not have a down time greater than 0.1 %

X a)



Analog DAS are used for measurement systems with wide bandwidth. But accuracy is less. So digital DAS which have high accuracy, low per channel cost and narrow bandwidth are designed.

The function of the digital DAS includes handly analog signals, making the measurement, converting and handling digital data, internal programming and control.

Digital DAS as shown in fig: Electrical quantities such as voltage, resistance and frequency may be measured directly. The signal conditioner includes the supporting circuitry for the transducer. This circuit may provides excitation power balancing circuits and calibration elements and an example of this is a strain-gauge bridge lence and Power supply unit. The scanner or multiplier accepts multiple analog inputs and sequentially connect them to one measuring instrument. The signal converter translates the analog signal to form acceptable by the ADC like an amplifier used for amplifying low-level voltage generated by thermocouples or strain-gauge. The output of the ADC may be displayed visually and is also available as voltage outputs discrete steps for further processing or recording on a digital recorder. The auxiliary section contains instrument for system programming and digital data processing such as linearizing and limit comparison. These function may be performed by individual instruments or by a digital computer. The digital recorder records digital information on punched cards, perforated paper tape, magnetic tape, typewritten pages or a combination of these systems. Digital recorders may be preceded by a coupling unit that translates the digital information to the proper form for entry into particular digital recorder selected. Fig 4 exp 5 A+5 =9 9

b)

S.No	Strip chart recorder	X-Y recorder.
1	Also known as X-t plotter	* Also known as X-Y plotter
2.	Input variable is plotted as a function of time	* one input variable is plotted as a function of other
3.	paper is kept rotating	* paper is held stationary
A.	Zero offset adjustment are not available	* Zero adjustments are available.

A+1.5 =6 6 6